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The Physicist and the Foundry

Some thirty years ago, a young man, now a well-known metallurgist, offered his services to a large engineering concern possessing its own foundry. His offer was not accepted on the grounds that the firm was well satisfied with the castings it made and it saw no reason for embarking on such an unnecessary overhead expense. We wonder to what extent this attitude of mind has changed. Certainly, the science of metallurgy is well entrenched in the foundry industry, and its benefits understood and appreciated. Yet, supposing a physicist appeared on the scene and asked for employment in a large concern having major foundry interests, what would be the firm's reaction? Most probably it would be: "Since we instituted metallurgical control in our foundry, we and our customers are well satisfied with our castings and we see no reason for embarking on an unwarranted overhead expense." This sounds very much like the story of thirty years ago, if one makes the mental proviso that for "craftsmanship" read "metallurgy."

Some foundry foremen of thirty years ago had a good smattering of metallurgy, and to-day many metallurgists have more than a nodding acquaintance with physics. Here, again, conditions are paralleled, and the question arises, would the directorate of a large foundry concern be justified in envisaging a future for the industry without serious and continuous help from the physicist. At the moment, the science of physics is used in foundry practice for the control of processes involving temperature and pressure measurements. It is used, though somewhat empirically, for the testing, and thereby the control, of sands—a fundamentally important subject which is well removed from metallurgy. Through tradition, the metallurgist has devoted much attention to the physicist's job of mechanical testing, mainly because the results so given were the concrete expression of his endeavours. Next came the radiological examination of castings and, because no numerical results are yielded, the metallurgist felt that this was a tool not too well adapted to his training, and there has not been a too-enthusiastic welcome to the undoubtedly good service it can render. More recently, there has been a second, and to our mind much more important, development in the X-ray field, and that is the quite different subject of diffraction analysis. This new method, now established in a very few foundries, and both allied and quite different types of industries, yields results relating to the actual atomic structure of materials; and whether they be stress free or exist in a stressed state. This subject will be dealt with in our columns in the near future, and its great importance will be revealed by references to the extraordinarily interesting results of real commercial value which are on record.

Here, then, is no question of providing the metallurgist with another tool, any more than the provision of a chemical laboratory would have helped the foundry foreman of thirty years ago. He required a metallurgist to superintend its conduct and co-operate for quality, control and production. Exactly the same position arises to-day, for the mere purchase of an X-ray machine and the handing over of it to the staff cannot be expected to yield results of scientific and economic value, unless the skilled physicist is called in to direct operations and interpret the observations made.

It is evident that the next stage in the scientific equipment of the foundry industry will be the fuller introduction and utilisation of the physicist in every branch of casting practice, and that the co-operation of the foundryman, the metallurgist and the physicist can be confidently trusted not merely to ensure the progress of the industry for the next decade or two, but also enable it to win back ground lost and conquer new.

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SETTING A CORE CENTRALLY

By W. G.

In moulding certain designs of castings where a round core has to be inserted it sometimes happens that more than usual care is necessary to set the core so as to be dead central. An example of a casting of this design is shown in Fig. 1. It represents a cast iron roller weighing a few pounds, and the method of making the mould will determine the simplicity or otherwise of setting the core centrally at the first attempt.

There are two methods of making the mould, the first being to use a two-part box and make a parting at B, when two ways of setting the core can be employed. One is to fasten a core print on top of the pattern one or two inches longer than the core, or, alternately to extend the hole through the top part of the box by ramming up a wooden plug, this latter method having the advantage as the core is visible when lowering the top part on to its mate and can be guided accordingly, though much care must be taken in this operation as the close fitting core will loosen the sand at the point where it contacts

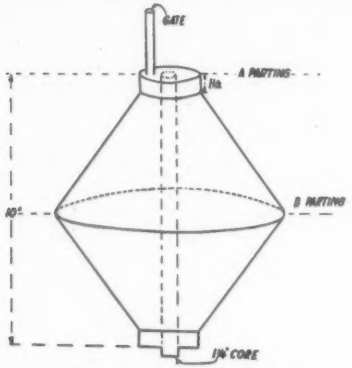

FIG. 1.—CAST-IRON ROLLER.

the runner, the loose sand falling to the bottom of the mould. Another way to get the centre of the core is to measure with callipers from its top to that part of the mould where the joint is shown at B. As accuracy is very difficult this method of getting a correct centre is not to be recommended.

The simplest and most certain way of centring the core is to mould a pattern in a three-part box, making partings, one at A, and another one at B, the box from A to B forming the middle part. This is lifted away to withdraw the pattern, and when replaced the core can be inserted in its print, when an accurate centre can be secured with the employment of callipers. It is important, of course, to make certain that firm contact is made between the top of the core

(*Concluded at foot of next column.*)

and that part of the mould which closes over it. This can be easily ascertained by lifting the top part to see if a "touch" has been registered, and if not a pinch of sand placed on top of the core will hold it securely in its place whilst the metal is being poured. If firm contact is not registered the molten iron will push the core out of centre.

IRON AND STEEL INSTITUTE

Annual General Meeting

The annual meeting of the Iron and Steel Institute was held in London on Thursday, May 7, 1942, Mr. John Craig, C.B.E., D.L. (President) in the chair. After opening the proceedings with a welcome to visitors from overseas, the president formally announced the award of the Bessemer gold medal for 1942 to Mr. Eugene Gifford Grace, Eng.D., of the Bethlehem Steel Corporation, saying that all recognised the great services which Mr. Grace had rendered to the industry not only in America but in its world-wide aspect. The Council had also invited Mr. Walter S. Tower (President of the American Iron and Steel Institute) and Mr. Harry Brearley, of Sheffield, a Bessemer medallist, to accept honorary membership of the Institute.

The Report of Council points out that the membership of the Institute at December 31, 1941, showed a decrease of 110 from the previous year, due to the loss of members resident in countries now involved in the war. During the year 26 members and one associate had resigned and 118 new members and 70 new associates had been elected. At the meeting 46 candidates for membership and 27 for associateship were duly elected.

The Secretary (Mr. K. Headlam-Morley) intimated that, in accordance with Bye-Law 10, the names of the following vice-presidents and members of Council were announced at the autumn meeting in 1941 as being due to retire at the present annual meeting:—Vice-Presidents: Dr. C. H. Desch, F.R.S.; Dr. W. H. Hatfield, F.R.S., and Sir William Larke, K.B.E. Members of Council: Mr. W. J. Brooke, Mr. E. J. Fox, Mr. J. Sinclair Kerr, Dr. T. Swinden, and Mr. A. B. Winder. No other members having been nominated up to one month previous to the present annual meeting, the retiring vice-presidents and members of council were presented for re-election, which was agreed.

Mr. John Craig vacated the chair, which was taken by the incoming President, Mr. James Henderson, who delivered his presidential address, outlining the evolution of the iron and steel industry of North Lincolnshire. After the address, the following Papers were presented for verbal discussion:—"Third Report of the Liquid Steel Temperature Sub-Committee"; "The Temperature Distribution in Liquid Steel in Various Steelmaking Furnaces," by D. A. Oliver and T. Land; and "The Work-Hardening and Ageing of Steel," by J. H. Andrew and H. Lee. The first two Papers were discussed jointly.

CUPOLA-MELTED HIGH-DUTY CAST IRONS

Practical Experience of a New Departure in Cupola Practice in Making High-Strength Irons

By W. W. BRAIDWOOD

(*Continued from page* 71.)

The structure of the test bar poured from melt No. 6 is illustrated in Figs. 5 and 6, preparation and magnification being respectively as detailed for the previous specimen. Here there is a good example of a composite graphite arrangement, two distinct and readily identifiable types being co-existent. Though the bulk of the graphite present is in the form of medium-sized random flakes, a considerable proportion is of the lacy, reticular type, and the areas involved are definitely dendritic. Again the matrix is of finely-divided pearlite, and the tensile strength is of the order of 24 tons per sq. in., but resistance to impact is now markedly improved. Figs. 7 and 8 show the micro-structure of the test bar poured from melt No. 20, preparation and magnification being exactly as previously described. In this specimen the graphite is present entirely in the form of long flakes in random dispersion. The distribution is completely haphazard, and there is no trace of reticular arrangement. As before, the matrix is pearlitic, and the tensile strength is approximately 24 tons per sq. in., but the resistance to impact is now practically twice that of the first bar. (It is noteworthy that in each instance in which calcium silicide was charged, the resultant test bar exhibited random graphite and high resistance to impact.)

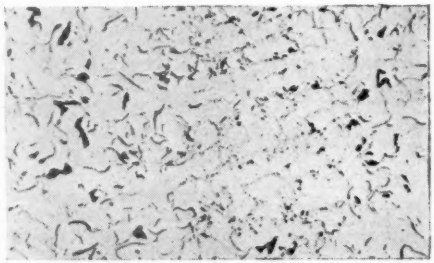

FIG. 5.—TEST-BAR FROM MELT NO. 6. UNETCHED × 50 DIA.

Reticular Graphite and Impact Resistance

Careful study of Table I will repay the interested investigator It will be observed that the presence of reticular graphite is always associated with lowered resistance to impact, though tensile strength does not appear to be appreciably influenced. It is desired to emphasise the latter fact, and the case of melt No. 88 may be studied. In this instance the cupola charge consisted of cast steel scrap and ferro-alloys only, and the resultant structure was the most markedly dendritic of any met with in the course of this investigation. The reticular pattern revealed in this polished specimen at the lower magnification (Fig. 9) is a thing of beauty, but, alas, not a joy for ever!

FIG. 6.—TEST-BAR FROM MELT NO. 6. PHYSICAL TEST RESULTS: HARDNESS, 241 BRINELL; TENSILE STRENGTH, 24.20 TONS PER SQ. IN.; IMPACT, 14 FT.-LBS. ETCHED (3 PER CENT. NITAL) × 250 DIA.

Fig. 10, which features the same specimen, in the etched condition, at a magnification of 250 diameters, shows the graphite to be lacy reticular entirely in a matrix of finely divided pearlite. This bar possessed high tensile strength, the average of two determinations in close agreement, being 25.95 tons per sq. in. Only when impact resistance is considered does the material become other than eminently satisfactory; the average of three concordant results being 10.3 ft.-lbs. only.

Tensile strength is undoubtedly an indispensable criterion of quality in cast iron, but surely, since the major inherent weakness of that material is its relatively low resistance to shock, the primary requirement of a high-grade iron is marked improvement in that property. It has been shown that the

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impact value of grey cast iron is primarily a function of the graphite form. Therefore, an obvious essential in the production of high-grade irons is the adoption of means whereby the presence in the casting of random flake graphite, and the entire absence of a reticular arrangement may be assured. This aim can be realised by the application of a well-known method to be discussed later. Meanwhile, attention may be diverted momentarily to a matter of very practical interest.

Returned Scrap and Lowered Quality

It had been feared that the inclusion of returned high-strength iron scrap in the cupola charge would be accompanied by deterioration in the physical properties of the resultant cast iron; and that, for consistent production of adequate strength, it might be essential to maintain the low-carbon, graphite-free type of charge. Happily, however, the actual results did not confirm this pessimistic theory. The anticipated increase in carbon content was found to be much less considerable than had been expected, and was not accompanied by appreciable lowering of the physical test results.

In one respect the prognosis was confirmed. Micro-examination revealed that increase in the proportion of returned scrap charged generally produced larger graphite flakes and caused progressive interference with the regularity of the graphite pattern, but the impact values showed this trend to be associated with increased toughness, and this modification in graphite form to be a definite advantage.

Indeed, the standard of the resultant iron is very satisfactorily maintained, despite the utilisation of returned scrap in proportions up to 50 per cent. of the total charge; and that figure probably represents the maximum which will be available in any foundry successfully making this type of

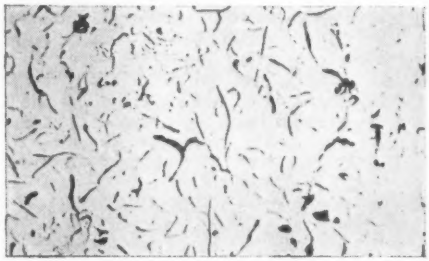

FIG. 7.—TEST-BAR FROM MELT NO. 20. UNETCHED × 50 DIA.

TABLE II.—*Influence of Charged Returned Scrap on the Properties and Structure of Unalloyed Irons.*

MELT No.	RETD. SCRAP IN CHARGE (%)	TEMPERATURE AT SPOUT (°C.)	CHEMICAL COMPOSITION (%) T.C.	C.C.	Si.	Mn.	S.	P.	PHYSICAL PROPERTIES: Hardness (Brn. No.)	Tensile (tons/sq.in.)	Impact (ft. lbs.)	MICROSTRUCTURE: GRAPHITIC	MATRIX
22 27 37	Nil	1420	2·86	0·54	2·41	1·28	0·095	0·041	252	23·35	14	See Table I	Pearlitic
26	19	1400	2·60	0·58	2·43	1·16	0·090	0·039	248	23·68	12	Mainly fine reticulum, but medium-size random flakes are present.	"
50	24	1390	2·81	0·86	2·91	1·17	0·096	0·065	262	23·84	13	Chiefly fine reticulum, but many "chubby" flakes are in evidence.	"
118	48	1380	2·83	0·87	2·68	1·09	0·097	0·054	241	24·30	13·5	Fine reticulum, and long random flakes in fairly equal amounts.	"
116	73	1360	2·97	0·56	2·83	1·17	0·070	0·042	266	22·22	14	Short flake reticulum, and long flake random, equally in evidence.	"
13	98	1340	2·98	0·51	2·85	1·07	0·113	0·058	241	21·66	—	Mostly in long random flakes, but a reticular pattern is discernible.	"

Balance of each cupola charge = selected steel scrap and/or ferro-alloys only.

castings for outside sale. The only disadvantage associated with the charging of returned scrap is the progressive lowering of spout temperature which accompanies increase in the proportion used to replace steel scrap. Again, however, this has no significance until fractions in excess of 50 per cent. are employed. (Actually in the home foundry, where most of the castings produced in alloyed, high-duty iron are returnable dies, etc., used in the firm's own forging shops, charges containing 70 to 80 per cent. of returned scrap are successfully in daily use.)

Evidence confirming these findings is provided

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in Tables II, III, IV and V, relating to unalloyed, chrome-molybdenum, molybdenum and nickel-chrome-molybdenum irons respectively. In Table III, for the compilation of which the greatest number of instances was available, the reported trends are most apparent. It will be observed, however, that the control exercised over graphite form by the melting of graphite-bearing scrap is not absolute, and considerable variation can occur even with the highest proportions of charged scrap. The need, therefore, for the adoption of some method by which the absence of dendritic structures can be assured is still outstanding.

American Research

Much effort has been expended in investigation of the exact nature of the process of graphite formation in grey irons. At the present time, the thanks of all interested are particularly due to the metallurgists of the U.S.A., whose latest researches have been so elucidating that part of this Paper will be devoted to a *résumé* of the most interesting recent publications.

D'Amico and Schneidewind have studied the influence of under-cooling on the solidification and graphitisation of grey irons. In their earlier Paper,[6] these co-authors describe experiments conducted on a wedge casting. The actual temperatures of solidification in various sections were observed, and it was found that rapid rates of cooling gave rise to appreciable under-cooling. Moreover, the faster the cooling rate—that is, the thinner the section studied—the greater the degree of under-cooling exhibited.

In the micro-structure of the wedge, widely differing types of graphite were observed. As the section thickness decreased, the graphite form gradually changed from long flakes in random distribution to very fine flakes in inter-dendritic arrangement. With sufficiently rapid rates of cooling, graphitisation was suppressed, with the formation of mottled and white irons. Similar examinations of other wedges showed that variations in composition, the addition of alloys and the application of ladle treatments merely altered the location, that is, the thickness of the section, in which the various graphite types were found—their positions relative to one another were unchanged.

Subsequent work,[7] in which use was made of specimens poured within heated metal moulds, confirmed these findings, and further demonstrated that the change from normal flake graphite to very fine graphite in reticular arrangement is a gradual transition controlled principally by the degree of undercooling experienced. Study of the effect of ladle additions of calcium silicide revealed that this

Melt No.	Mtls. Scrap in Charge (%)	Temperature at Spout (°C)	Chemical Composition (%) C	Si.	Mn.	S.	P.	Cr.	Mo.	Physical Properties Hardness (Brin. No.)	Tensile (Tons/in²)	Impact (ft. lbs.)	Microstructure: Graphite	Matrix
79b	Nil	1430	2·48	2·74	1·37	0·059	0·059	0·51	0·01	388	28·98	11	Fine lazy reticular, centrally	Fine pearlite; some free carbide.
106b	Nil	1420	2·69	2·59	1·28	0·067	0·025	0·51	0·04	295	27·82	11	as above.	"
Average for five melts:-		1425	2·59	2·67	1·29	0·063	0·042	0·51	0·03	302	28·36	11		
78	67	1400	2·86	2·58	1·03	0·081	0·079	0·05	0·06	298	29·22	14	Medium random, and fine flake reticular, equally represented.	Fine pearlite; trace of free carbide
97	"	1390	2·71	2·55	1·38	0·054	0·047	0·56	1·02	321	29·22	13	Predominantly short flake reticular only a few normal flakes present.	Fine pearlite; some free carbide.
104b	"	1398	2·83	2·60	1·16	0·118	0·025	0·69	1·02	308	29·28	14	Mainly short flake reticular, but some normal flakes are evident.	"
115	"	1400	2·88	2·64	1·28	0·066	0·026	0·66	0·75	295	28·42	12·5	Predominantly short flake reticular, only a few normal flakes present.	"
Average for four melts:-		1395	2·68	2·48	1·19	0·071	0·045	0·56	0·92	303	28·29	13·4		
90	57	1370	3·13	2·48	1·54	0·048	0·062	0·56	0·64	293	27·44	16·5	Mainly in random flakes, but a reticular pattern is discernible.	Fine pearlite; some free carbide.
100	66	1350	3·25	2·36	1·32	0·075	0·059	0·48	0·62	267	27·16	18	as above.	"
103	"	1360	3·18	2·27	1·38	0·075	0·056	0·61	0·67	299	28·68	19	Medium random, and fine flake reticular, equally represented.	"
Average for three melts:-		1360	3·16	2·37	1·41	0·066	0·052	0·55	0·64	286	27·73	16·5		
107	99	1340	3·05	2·73	1·48	0·086	0·041	0·43	1·02	253	25·76	18	Mainly in random flakes, but a reticular pattern is discernible.	Fine pearlite; some free carbide.
114	"	1338	3·08	2·61	1·64	0·062	0·059	0·51	0·03	228	24·62	13·5	Normal random, and fine flake reticular, equally represented.	"
Average for two melts:-		1335	3·06	2·67	1·22	0·054	0·046	0·53	0·02	239	25·18	16·0		
Balance of each cupola charge:— Selected steel scrap and/or ferro-alloys only.														

TABLE III.—*Influence of Charged Returned Scrap on the Properties and Structure of Chrome-Molybdenum Irons.*

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treatment greatly extends the range of undercooling over which graphite of the normal flake type is formed, the degree of undercooling necessary for the production of mottled and white irons being markedly increased. That is to say, in iron so treated, the tendency to graphitise, or, the urge to form grey iron, is much stronger than in an untreated iron of the same composition.

Graphite Formation

The process of graphite formation has been further studied by Eash,[8] whose preliminary work demonstrated that inoculated, low-carbon irons freeze at higher temperatures, and exhibit shorter eutectic arrests, than do untreated but otherwise similar irons. These differences in behaviour were observed to coincide with the production of normal flake, and fine reticular graphite in the respective sets of test bars. This suggested that the eutectic of the inoculated irons was freezing differently from that of the untreated irons. To obtain more direct evidence, specimens poured from "as-melted" and inoculated irons were each quenched from just below the observed eutectic temperature, that is, immediately after completion of freezing in each case.

The structure of the

Melt No.	Returned Scrap in Charge (%)	Temperature at Spout (°C)	Chemical Composition (%) C	Si.	Mn.	S.	P.	Mo.	Physical Properties Hardness (Brin. no.)	Tensile (tons/sq. in.)	Impact (ft.-lbs.)	Microstructure: Graphite	Matrix
32	Nil.	1430	2·89	2·29	0·97	0·089	0·031	0·48	262	30·44	–	Flaky short flake reticular, but many random flakes are present.	Fine pearlite; about 8% of field acicular.
51	"	1420	2·84	2·73	1·48	0·096	0·039	0·47	321	29·20	12·5	Fine flake reticular, entirely.	Fine pearlite; approx. 5% of field acicular.
Average for five melts		1423	2·72	2·52	1·39	0·082	0·045	0·48	302	29·82	–		
35	17	1400	2·83	2·35	1·16	0·062	0·039	0·47	293	30·54	17·5	Mainly medium random flakes but reticular pattern traceable.	Fine pearlite; roughly 5% of field acicular.
41	28	1390	2·66	2·35	0·91	0·082	0·092	0·47	305	28·96	–	Fine flake reticular, entirely.	Fine pearlite; about 15% of field acicular.
56	38	1370	2·91	1·87	0·73	0·079	0·032	0·92	274	24·80	14·5	Medium random, and fine flake reticular; fairly equally present.	Fine pearlite; approx. 5% of field acicular.
54	41	1360	2·93	2·40	1·25	0·089	0·033	0·89	285	28·46	16·5	Chiefly in random flakes, but a reticular pattern is evident.	Pearlite only; some resolved at 250 diams.
53	56	1370	2·73	2·33	1·19	0·080	0·039	0·85	280	27·96	–	Medium random, and fine flake reticular, equally represented.	Fine pearlite; about 10% of field acicular.
Balance of each cupola charge—selected steel scrap and ferro-alloys only.													

TABLE IV.—*Influence of Charged Returned Scrap on the Structure and Properties of Molybdenum Irons.*

Melt No.	Returned Scrap in Charge (%)	Temperature at Spout (°C)	Chemical Composition (%) C	Si.	Mn.	S.	P.	Ni.	Cr.	Mo.	Physical Properties Hardness (Brin. no.)	Tensile (tons/sq. in.)	Impact (ft.-lbs.)	Microstructure: Graphite	Matrix
48	24	1420	2·90	2·47	1·46	0·102	0·056	1·18	0·44	0·92	354	31·50	–	Test pieces lost; no specimen available for examination.	
61	31	1400	2·94	2·31	1·32	0·068	0·037	1·16	0·60	0·97	341	27·28	12	Mainly fine flake reticular, but some random flakes are present.	Fine pearlite; approx. 25% of field acicular.
68	47	1380	3·08	2·28	1·32	0·083	0·049	0·96	0·49	1·06	388	27·00	–	Very fine reticular. Small grain size denotes much undercooling.	Fine pearlite; 5% of field acicular; some carbide.
67	"	1380	2·76	2·46	1·16	0·058	0·087	1·18	0·65	0·98	318	29·80	12	Mainly fine flake reticular, but many random flakes are present.	Fine pearlite, traces of free carbide present.
Average of five melts		1380	2·91	2·37	1·09	0·071	0·065	1·03	0·57	1·05	323	28·40	–		
64	78	1370	3·03	2·21	1·52	0·071	0·057	1·00	0·42	0·89	288	27·50	18·5	Mainly medium random flakes, but a reticular pattern is traceable.	Fine pearlite; roughly 10% of field acicular.
65	"	1360	2·99	2·24	0·99	0·068	0·130	0·94	0·65	0·90	286	26·52	14·5	Chiefly in random flakes, but a reticular pattern is discernible.	Finely-divided pearlite, entirely.
66	"	1370	3·02	2·43	1·20	0·060	0·070	1·06	0·68	0·97	299	28·06	16	Predominantly in random flakes; background only faintly discernible.	Finely-divided pearlite, entirely.
68	"	1350	2·90	2·30	1·09	0·069	0·082	0·90	0·59	0·86	341	27·28	12·5	Mainly fine flake reticular, but some random flakes are present.	Fine pearlite; about 15% of field acicular.
69	"	1350	3·05	2·31	0·98	0·076	0·081	1·04	0·60	0·85	315	28·14	12	Normal random, and fine flake reticular, equally represented.	Fine pearlite; approx. 5% of field acicular.
Average of five melts		1360	3·00	2·34	1·03	0·069	0·084	0·99	0·41	0·86	306	27·50	14·7		
Balance of each cupola charge—selected steel scrap and ferro-alloys only.															

TABLE V.—*Influence of Charged Returned Scrap on the Properties and Structure of Nickel-Chrome-Molybdenum Irons.*

former specimen consisted of the primary dendrites rendered martensitic by the quench, with carbide in massive and eutectic form

FIG. 8.—TEST-BAR FROM MELT NO. 20. PHYSICAL TEST RESULTS: HARDNESS, 229 BRINELL; TENSILE STRENGTH, 24.36 TONS PER SQ. IN.; IMPACT, 21 FT.-LBS. ETCHED (3 PER CENT. NITAL) × 250 DIA.

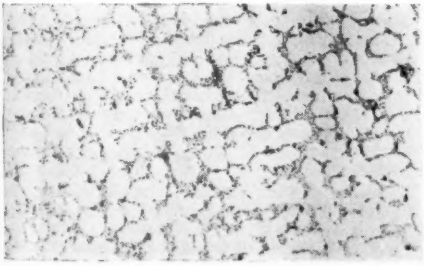

FIG. 9.—TEST-BAR FROM MELT NO. 88. UNETCHED × 50 DIA.

in the interstices. An identical bar, cooled in the mould, was completely grey with fine graphite in inter-dendritic distribution. Obviously, this had been formed by decomposition of the carbide originally present. An inspection of Fig. 10 which illustrates the most markedly dendritic structure of personal experience will reveal the presence of carbide in intimate co-existence with the lacy reticular graphite. This provides confirmation of the mode of formation postulated above. The quenched bar from the inoculated melt was completely grey, the graphite being entirely in the flake

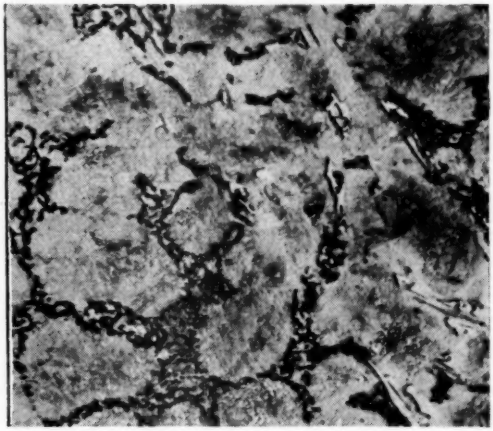

FIG. 10.—TEST-BAR FROM MELT NO. 88. CHEMICAL ANALYSIS: T.C, 2.66 PER CENT.; C.C, 0.61; SI. 2.41; MN, 1.29; S, 0.056; P, 0.033 PER CENT. PHYSICAL PROPERTIES: HARDNESS, 277 BRINELL; TENSILE STRENGTH, 25.95 TONS PER SQ. IN.; IMPACT RESISTANCE, 10.3 FT.-LBS. ETCHED (3 PER CENT. NITAL) × 250 DIA.

form, as was that of the companion bar cooled in the mould. This graphite had evidently formed directly from the liquid.

A further bar from the inoculated melt, quenched from a temperature immediately above the freezing point of the eutectic, was found to exhibit a mottled fracture of most peculiar type. Around the edge of the section the structure was completely grey, containing flake graphite. Adjacent to this outer rim, a mixture of eutectic carbide and specks of graphite occupied the dendritic interstices. The central area was grey, with fine graphite in very reticular arrangement. This remarkable structure is explainable in the light of the information already gleaned. At the instant of quenching the exterior of the bar was completely solid and flake graphite had formed directly. In the interior, however, where freezing of the eutectic liquor had not yet begun, the quench caused formation of the meta-

Cupola-Melted High-Duty Irons

stable carbide phase. In the outer annulus, through which heat transfer was rapid, subsequent breakdown of the carbide was limited, but, in the centre, where cooling was less drastic, a greater degree of decomposition was possible, the resultant grey iron containing fine reticular graphite only.

Eash suggests that inoculation produces nuclei which initiate the separation of graphite from the liquid with the formation of random flakes. Following successful inoculation by the addition of powdered graphite, he considers it probable that the inoculating nuclei are particles of graphite. He states: "It is entirely possible that late ferro-silicon additions produce a shower of minute graphite particles in the ladle due to localised silicon concentrations reducing the carbon solubility."

The following are among the conclusions reached by this investigator:—

(*a*) "Grey irons, having fine graphite in a dendritic pattern, solidify in the metastable iron-carbide system as white irons. The eutectic carbide subsequently decomposes in the solid state to form iron and graphite."

(*b*) "Ladle inoculated grey irons, having random flake graphite, solidify in the stable iron-graphite system. The flake graphite forms during the freezing of the graphite-austenite eutectic."

(*c*) "It is believed that inoculation produces graphite nuclei which cause the iron to solidify in the iron-graphite system."

(*To be continued.*)

BOOK REVIEW

Tin Solders. By S. J. Nightingale. Second edition, revised by O. F. Hudson. Published by the British Non-Ferrous Metals Research Association, Euston Street, London, N.W.1. (Price, 10s. 6d. post free, or $2.75 for U.S.A. readers.)

This is the standard work on the subject of tin solders, and amongst standard works it ranks high. It came as no surprise to the reviewer that a second edition was required, for in recent times it is being difficult to obtain. Naturally since it was first published ten years ago, additional knowledge has been forthcoming, and this has been incorporated by Dr. O. F. Hudson, who has been closely associated with recent work carried out by the B.N.F.M.R.A. The time of publication is particularly opportune, as the first requisite for economy of tin in any alloy, be it a solder or a bronze, is a full knowledge of fundamental principles, and these are set out with extreme clarity.

V. C. F.

LIMIT OF PROPORTIONALITY

TERMS FREQUENTLY CONFUSED

Discussing testing terms and methods which are frequently confused, GEORGE P. LENZ, in "Metal Progress," includes some remarks on the "proportional limit." He suggests that it is very possible that the person who sets up a specification writes "elastic limit" when he really means "yield point," or possibly he says he wants the "proportional limit" when the design is really figured on a "yield strength" value. The correlation of these testing terms as to their position on the stress-strain curve may help in straightening out this confusion.

It is agreed that the determination of the true elastic limit is beyond the scope of ordinary testing equipment. This brings us to the closest practical approach, namely, the proportional limit.

According to the A.S.T.M. Standards for 1939, the proportional limit is "the greatest stress which a material is capable of developing without a deviation from the law of proportionality of stress to strain." (Hooke's law states that, below the elastic limit, the deformation produced is proportional to the stress.) There are two commercially practical ways to determine the proportional limit. First, and most satisfactory, is the use of an autographic stress-strain recorder. This will draw a curve from which one can determine the proportional limit by laying a straight-edge along the straight, or proportional, part of the curve, and thus approximate the position at which the recorded curve deviates from the straight line. In the second method this value can be found with an extensometer. With the extensometer attached to the specimen, the load is applied and corresponding readings of strain (stretch) and stress (load) are recorded. Either equal increments of stress or strain should be used, depending on which is the easier to control. This will give the necessary points to plot the stress-strain curve, thus making it possible to determine the proportional limit. A fair idea may be had from inspection of the results: If the load is increased by 2,000-lb. steps, the specimen will elongate by equal amounts until the proportional limit is passed. The term "proportional limit" is a good one for it defines itself.

The proportional limit can only be determined on those materials having a portion of the stress-strain curve which is a straight line. Otherwise there is no proportionality between stress and strain, and no proportional limit. Hot-rolled, annealed, heat-treated, or stress-annealed steels possess a proportional limit. Inasmuch as cold-worked material does not follow Hooke's law of proportionality, the term proportional limit should not be applied to it. This also eliminates any tests on cold-worked material whose interpretation requires that a parallel line be drawn to the region of proportionality, as in offset methods. Cold-worked materials must be stress-annealed in order that test samples may show a region of proportionality in the stress-strain curve.

LINING AN INDUCTION FURNACE

The technique of lining small electric induction furnaces is described in an article by HENRY C. FISHER in "Metal Progress," who points out that to obtain a maximum life from any refractory material, it must be rammed to maximum density. If open and porous, slag and metal will readily penetrate and mechanical erosion will be rapid; likewise a refractory material that does not shrink appreciably at furnace temperatures should be used. In fact, a small permanent expansion is generally desirable.

As is well known, the widely used Ajax-Northrup high-frequency induction furnace is ordinarily encased in a cubical box or frame. Essentially the furnace is an open topped crucible, tilting about its lip, the crucible being surrounded by a helical conductor carrying alternating currents at high frequency. Such conditions set up circulating currents in the metal contained in the crucible, and these currents convert their energy into heat. The problem of lining such a furnace, therefore, is to construct a satisfactory crucible within the main coil.

The crucible in the induction furnace is actually a separator between the charge and the primary coil. This separator must combine several properties such as electrical insulation, heat insulation, refractoriness, and chemical inertness to the metals making up the charge and their oxides. The kind of refractory used—that is, whether acid, basic, or neutral—will be governed by the kind of charge to be melted and the kind of slag, if any, to be used on top of the charge.

Details of Procedure

The first operation is to plaster up the inner surface of the coil. For this purpose use a fine, dry cement similar in chemical composition to that to be used for the inner lining or crucible, 20 mesh and finer, of good workability, and mix to a medium plastic condition with sodium silicate and water (commercial water-glass diluted with an equal volume of water). Work the mixture tightly against and between the successive turns of the coil. This cement layer should be between $\frac{1}{4}$ and $\frac{1}{2}$ in. thick over the coil.

Next moisten the inside surface of the cement layer with sodium silicate (commercial water-glass) and line with asbestos cloth, approximately $\frac{1}{4}$ in. thick.

Again moisten the inside surface of the asbestos cloth with sodium silicate and plaster on a second layer of cement, approximately $\frac{1}{4}$ in. thick, similar in composition to the first layer. It is well at this point to cover the bottom of the furnace with about 1 in. of the same cement, rammed well in place.

A total thickness of between $\frac{1}{2}$ and $\frac{3}{4}$ in. of lining has now been put in the furnace, whereupon the whole should be thoroughly dried by suspending two or three 100-watt incandescent lamps inside the shell, loosely covering, and leaving for at least 24 hrs.

If the lining up to this point has been carefully applied, four things will have been done: (1) A rigid support for the coil will have been obtained, and the coil will be held firmly in place. (2) Adequate protection of the coil against subsequent damage during the final ramming operation will have been attained. (3) A layer of cement in intimate contact with the coil will provide maximum cooling of the refractory by the cooling water in the coil. This last factor is of first importance if maximum life is to be had from the lining. At critical temperatures for a refractory, a lowering of the temperature of the refractory face of only 50 deg. C. can readily mean the difference between success and failure. Chemical activity between the slag and the lining is accelerated with an increase in temperature. (4) The coil will be protected with a refractory material, not far different in chemical composition from that of the lining itself, and having a degree of flexibility to minimise the tendency to crack.

Furnace Bottom and Crucible

After the plastic cement coating for the protection of the coil has dried, take the dry material for the inner lining, and put a sufficient amount in the bottom of the furnace to form a rammed bottom about 5 in. in depth. Ram thoroughly with a large rivet hammer fitted with a flat butt.

Now place a special cylindrical sleeve, made of "transite" for the purpose, in the furnace to form the crucible. Insert a wood core inside this sleeve for support. Ram the dry cement in layers solidly around the sleeve to a point approximately 1 in. above the metal line. This can best be accomplished by using the rivet hammer and a long flat tool. Work the dry cement thoroughly into place. Finish off the top of the crucible with the same kind of cement made plastic with water to which a small amount of sodium silicate has been added. If time will permit, let the top layer of plastic cement dry before heating the furnace.

The wood core inside the transite sleeve should next be removed and the furnace charged for the first heat of metal. This heat will sinter a thin layer from $\frac{1}{8}$ to $\frac{1}{4}$ in. deep on the face of the crucible. At the same time it will flux away the transite sleeve. This fluxing action also assists in providing a glazed, impervious face to the crucible.

Assuming that the refractory has been properly chosen, good service should be expected. When the furnace cools, the sintered face may crack; however, these cracks will not extend back through the unsintered portion of the crucible lining and will not cause subsequent trouble. If properly installed, one outer lining should suffice for from three to four inner crucible linings.

Gouge Resistance of Vitreous Enamels.—Experiments carried out by W. G. Cooper and G. H. Spencer-Strong to compare the effect of several enamels and combinations of enamels with the effect of application weight and firing procedure on the gouge resistance, as determined by the gouge resistance machine developed by the Porcelain Enamel Institute, were described at the recent convention of the American Ceramic Society. This test appears to correlate better with the actual deep scratching observed in the use of vitreous enamels than previous similar tests.

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NSTITUTE OF BRITISH FOUNDRYMEN

LONDON BRANCH

The annual general meeting was held on April 30 at the National Liberal Club, the Branch-President (Mr. R. B. Templeton) in the chair. Apologies for absence were received from Mr. Wesley Lambert (Past-President of the Institute and of the Branch) and Mr. C. C. Booth, J.P. (Past-Branch-President).

Minutes.—On the motion of Mr. R. Pipes, seconded by Mr. C. H. Kain, the minutes of the previous annual general meeting of the Branch, held on June 7, 1941, were taken as read and were confirmed and signed.

Hon. Secretary's Report

MR. V. C. FAULKNER (past-President and hon. secretary) presented his report for the year 1941-42, as follows:—

Finance.—The London Branch income at £521 17s. was the second highest ever recorded, being £25 lower than last year. The expenses, reflecting as they do increased activity, rose from £37 to £62.

Technical.—Since the last annual general meeting, technical meetings have been held every month, except August and December, and a very wide range of subjects has been covered, including Mass Production, and the Maintenance of Quality; High-Duty Iron; Die Castings; Recent Developments in Foundry Practice; Recent American Research Work in Cast Iron; Running of Castings (illustrated by a film display); the Co-ordination and Diffusion of Metallurgical Literature; and Economy in Core Production. This is a record of which the Branch may well be proud.

Membership.—There are at present 361 names on the London register which undoubtedly constitutes a record. Mainly through the effort of the President, twenty new members have been elected to the various grades, which after deduction for loss by death, transfers to other branches and erasures, leaves a net gain of nine.

Obituary.—The Branch has suffered an irreplaceable loss through the death of Mr. A. R. Bartlett. For thirty years he made a continuous effort for its welfare, filling with distinction, most of the offices. His work was acknowledged by the Institute when it awarded him the Oliver Stubbs Medal. A second loss was incurred through the death of Mr. Joseph Deschamps. Besides his direct interest in the London Branch, he participated very enthusiastically in the work of the Steel Castings Sub-Committee. Though he had not been a member of this Branch for some years, there will be sincere regret felt for the passing of Mr. H. J. Maybrey, who lectured to the Branch as recently as last September.

East Anglian Section.—Under the chairmanship of Mr. George Hall, the Section has had a particularly successful year and a number of the Papers presented have been selected for inclusion in the Institute's Proceedings. Moreover, the Section, in co-operation with the local educational authorities, has created courses in foundry practice and science, and patternmaking, at the Ipswich Technical College. The local firms have largely made themselves responsible for providing the necessary equipment.

Distinctions.—Two of the Branch members hold important positions in the Ministry of Supply. Mr. A. E. Chell is co-director of Iron Castings and Mr. N. L. Goodchild, director of Pig-iron.

Conclusion

The pleasing character of the above report has been made possible by the enthusiastic support so consistently accorded by the President and the Council. The thanks of the Branch are due to Mr. J. L. Francis, the extremely efficient honorary secretary of the East Anglian Section; to Mr. Barrington Hooper and Mr. P. Ellis, who have shared the duties of operating the lantern; to Mr. J. Bolton, the acting secretary of the Institute, for his kindly co-operation; and to Sir Paul Booth, the chairman of the Management Committee of the National Liberal Club for the use of the meeting room.

The report having been adopted, the following appointments to office were made:—

Branch-President: Mr. R. B. Templeton; *Vice-Presidents*: Mr. H. W. Lockwood and Mr. A. J. Murphy, M.Sc.; *Hon. Secretary*: Mr. V. C. Faulkner; *Members of Council*: Mr. F. Arnold Wilson; Mr. A. W. G. Bagshawe, and Mr. G. R. Webster (re-elected), and Mr. E. M. Currie and Mr. J. F. Kayser, Assoc.Met. (co-opted); *Hon. Auditors*: Mr. C. Cleaver and Mr. V. Delport; *Delegates to the General Council*: Mr. C. H. Kain; Mr. C. C. Booth, J.P., Mr. H. W. Lockwood and Mr. B. B. Kent; and *Representatives on the Technical Committee*: Mr. C. H. Kain and Mr. A. J. Murphy.

Foundry and Metallurgical Brains Trust

Following the annual general meeting, the first meeting of the Foundry and Metallurgical Brains Trust was held. A number of questions on foundry and metallurgical problems were submitted and were discussed by the Brains Trust. This new departure proved to be both entertaining and instructive. The guest participants were Dr. C. H. Desch, F.R.S., and Mr. E. Longden, A.M.I.Mech.E., of Manchester

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"Ferrital" is a mild steel being produced in Italy in the electric-arc furnace from a concentrate of ferruginous sands by the process of V. Arata and F. Venzi. This product, whose physical and chemical properties are described by A. REGE in "Metallurgia italiana," contains less than 0.01 per cent. C, 0.01 per cent. Si, 0.02 per cent. Mn, 0.01 per cent. P, 0.02 per cent. S, and 0.02 per cent. Cu. The Fe is over 99.93 per cent. It is recommended as a substitute for copper and brass.

Iron for Ingot Moulds.—On the basis of extensive trials, I. G. ARSAMASSZEW and his collaborators recommend in "Uralskaja Metallurgija" for ingot moulds the use of a cast iron with 3.7 to 3.8 per cent. C, 1.4 to 1.7 per cent. Si, 1.4 to 1.6 per cent. Mn, approx. 0.15 per cent. P, and 0.03 per cent. S, which has been superheated to 1,300 to 1,350 deg. C. to obtain a fine graphite distribution, and finally poured at 1,170 to 1,200 deg.

MALLEABLE CASTINGS BY THE WHITEHEART PROCESS

Discussion of A. E. DAVIES' Paper by the East Midlands Branch

In the absence of the author, Mr. A. E. Davies' Paper* on "The Manufacture of Malleable Castings by the Whiteheart Process" was presented, on February 28, to the East Midland Branch of the Institute of British Foundrymen for discussion by Mr. H. L. Sanders.

The BRANCH-PRESIDENT (Mr. H. J. Beck), opening the discussion, said he was surprised to note that Mr. Davies had not gone into more detail regarding the method of feeding and gating malleable-iron castings. After a lifetime's experience in the production of this type of casting in a foundry where there were 1,200 to 1,300 different types of castings produced in any week, varying in section from $\frac{1}{8}$ in. to 1 in., many of them fragile and of intricate design, he considered this was one of the most essential phases of manufacture.

Methods of feeding and gating could not be described as just skimgate or spinner, as they necessitated careful consideration by the foundry executive before the pattern equipment was produced. In some instances, the best way to mould a submitted design was not always satisfactory from a feeding and gating viewpoint. In many cases, alteration in design had to be suggested by the foundry, as the castings as designed were almost impossible to produce.

When outlaying a casting for production, the following points must receive attention:—(1) Whether to use a spin feeder or skimgate or a combination; (2) whether it will be necessary to remove gates and feeders when casting is plastic; (3) whether to normalise or not; (4) whether to use denseners, and, if so, whether to use them in the core or mould; and (5) where to bracket or tie to prevent hot tears. Mr. Davies could with interest have included data giving particulars of the ratio of weight of sprue to weight of good castings produced.

MR. A. E. PEACE said the Paper was certainly comprehensive and was concise from the point of view that it did not go into very great detail. There were not much data submitted, but it was certainly provocative of discussion and could bear useful enlargement in certain places. When dealing with melting methods, the author referred to decided advantages the rotary furnace had over all other methods of melting malleable-iron mixtures. He did not dispute this, and added that the cupola also had advantages: this might be said for any method of melting.

Graphite, Manganese and Sulphur

In a number of places, Mr. Davies rightly warned against compositions which tend to give primary graphite, that is tended to graphitise during solidification and cooling in the mould. It was most important in malleable that this formation of graphite should be avoided, since the graphite forms in a flakey structure, as in ordinary cast iron, and this structure, on annealing, tended to give network formations which weakened the metal. He asked how the freak composition of 0.8 per cent. sulphur was obtained. Presumably it would be necessary to obtain this composition by the addition of, say, ferrous sulphide. He did not agree with the author's statement regarding manganese and sulphur, that a manganese content twice that of sulphur was desirable.

This was excessive for the production of a true whiteheart, and with a manganese content so much in excess of the sulphur there would be a considerable tendency to graphitisation during annealing, and to the production of a semi-blackheart. Referring to the author's statement that "the use of denseners or chills is very popular in the malleable foundry, particularly when high-duty castings are required, or when the castings have to be routine tensile tested, which is often the case with malleable castings," Mr. Peace said tensile tests were usually carried out on test-bars. It was most unusual for tensile tests to be carried out on the actual castings. Further on the writer says:—"Over-chilling should be avoided, since this causes weakness." He (the speaker) was not quite clear as to the manner in which this caused weakness, unless it be by physical defects, such as "cold laps." The effect of chilling upon the properties of the metal was certainly beneficial, producing smaller grain size; and more rapid migration of carbon was obtained, thus facilitating annealing. Regarding the "malleablising process," the author referred to regulating the mixture so that the metal would anneal in a shorter time. This is a matter which he would not dispute, as it depended upon the annealing temperature, and also upon the section of the casting.

* See "Foundry Trade Journal," March 12, 1942.

Whiteheart Malleable Castings

MR. SANDERS, in reply to Mr. Peace, said that the cupola and the rotary each had their several advantages as melting media. The cupola was more elastic, but the rotary was stated to give better control of melting and the advantage of a lower carbon content. If a carbon content of below 3 per cent. was consistently maintained in the rotary furnace, it helped the annealing process and in general gave better mechanical properties than with cupola metal where the carbon averages 3.25 per cent. or higher. Mr. Sanders agreed with Mr. Peace about the danger of primary graphite in the castings, as this was fatal. In the case of 0.8 sulphur, it was assumed that Mr. Davies added ferrous sulphide, the castings showed no evidence of primary graphite, as the following extract from Mr. Davies' letter will show:—

> "I do not recommend the use of freak mixtures such as 0.8 per cent. sulphur and 1.2 per cent. silicon, but the resulting unannealed castings showed no evidence whatsoever of graphite, although the section thickness was about one inch. No mechanical tests were taken, the fracture of the annealed casting showed a particularly small grain size, and good results were obtained when the casting was tested to destruction. This instance was mentioned to point out the importance of securing the carbon in the combined condition, and also the neutralising effect that certain elements have upon each other, particularly of silicon and sulphur."

MR. SANDERS agreed with Mr. Peace that with a manganese content of twice the sulphur, one was liable to get varying fractures, such as blackheart or semi-blackheart, depending on the thickness of section and the annealing cycle. Mr. Sanders was afraid, in this statement, he was not defending Mr. Davies too well, but when one was making ordinary malleable castings, he supported Mr. Davies in that the manganese content of twice the sulphur would be very helpful in shortening the annealing time, which would save money and also time in delivering the castings, which was of importance in a malleable foundry. Where one was making true whiteheart castings, the manganese should be approximately equal to the sulphur, or not more than 0.05 per cent. in excess, so that no precipitation of temper carbon could take place.

Denseners and Chills

The point which Mr. Peace had raised was very important, so that Mr. Davies was communicated with and in reply he stated:—

> "Test-pieces cast entirely in chills have always given negative results in my experiments. Various types of test bars have been used; shouldered test bars are hopeless, which is probably due to small contraction during cooling in the mould. With plain test bars, the results were never so good as sand cast test bars. The chills in each case were practically cold. In the case of bend tests of chilled castings where the chill was used on one side of the mould only, the castings bent very well if the chilled part of the casting is the outside, *i.e.*, the tension side, if the reverse is the case and the chilled part of the casting is in the inside diameter, *i.e.*, in compression, then the bend test is as poor as the alternative way was good. Most of the test bars cast in chills were perfectly sound, precautions being taken to make them so."

Mr. Sanders, continuing, said the statement that overchilling caused weakness probably required qualifying, because of the physical defects resulting from the extremely rapid cooling. With a cold chill there was no time for the escape of gas, which hence struck back into the metal and might be trapped there. Again, metal did not lie very kindly on a cold chill, especially if the chill was massive and did not heat up quickly. When chilled castings have been fractured, they have had a fine grain size, which as Mr. Peace said assists in the annealing process.

Mr. Sanders stated he had seen a few malleable castings welded electrically. It was assumed that the castings would be chiefly ferrite and would stand the re-heating without re-solution of carbon. These castings were subsequently machined and it is most probable that under good conditions, welded malleable castings would be quite successful.

Metal Mixtures

MR. GOODWIN said the author, referring to metal mixtures, stated that hematite irons are the base of these mixtures. That was bound to be so in cupola practice. He also stated that steel scrap, if used at all, is used very sparingly. He personally had had the unfortunate experience of having to make whiteheart malleable from thin steel sheets and no pig-iron. When Mr. Davies says that the rotary was the best medium he was inclined to agree with him, because the silicon or carbon can be increased, if necessary, which was necessary if large percentages of steel were used, and carbon was really the controlling element. Some people might say that silicon was the controlling element, but he favoured carbon.

Regarding the functions of silicon, the author says "small sections which are very difficult to cast economically in the foundry can be cast quite easily and safely with a mixture of considerably in excess of 1 per cent. of silicon." Exceeding 1 per cent. of silicon in whiteheart castings was

liable to cause trouble. He agreed with Mr. Peace that the general practice was for the silicon content to be fairly low.

Hatfield Annealing Cycle

In regard to short-cycle annealing, he would like to touch on an annealing cycle which was devised by Dr. Hatfield some years ago, and disclosed in a comprehensive study. He started off with what is a recognised whiteheart analysis, 3.5 per cent. combined carbon with no graphite, manganese only a trace, silicon 0.50 per cent., sulphur 0.35 per cent., and phosphorus 0.05 per cent. These were packed in the usual manner with a mixture of three of old ore to one of new ore, and it went through the recognised whiteheart process of annealing. There was only one way that one could change the annealing process, and that was if the analysis was altered initially. The annealing took 90 hrs. to reach a temperature between 980 and 990 deg. C., and was held between 990 and 950 deg. for 80 hrs. Therefore, he could not understand this 15-hr. cycle. After the 80 hrs. at 950 deg. C., the temperature was gradually lowered at a rate of 7 deg. per hr., and it took 50 hrs. to cool down to 600 deg., and after that one could not do much harm. During all that time there were 10 samples taken from that anneal, and they were all checked up on. The first test was taken at a temperature of 750 deg. C., the second at 800 deg. C., the third at 900 deg. C., and another at 980 deg. C. Five other tests were taken while the temperature was at 950 deg. C. The last test was taken when the temperature had reached to 600 deg. C., and that, Dr. Hatfield said, was a perfect sample of English whiteheart malleable iron. The analysis of the finished product was: Combined carbon, 0.65; temper carbon, 1.10; sulphur, 0.35, and phosphorus, 0.05 per cent.

MR. SANDERS said the author's statement that a few years ago manufacturers of malleable castings used almost exclusively a refined hematite mixed only with returned annealed scrap was perfectly correct, and many foundries were using this material to-day. In the cupola, steel scrap was rather tricky and gave difficulty in obtaining even-melting and constant composition. With grey iron there was a little more latitude in this respect than with malleable iron. Evidently Mr. Goodwin also appreciated the rotary furnace, in agreement with the speaker, for it had some very good points. With it one could use straight blast-furnace hematite, steel scrap or ingot mould scrap and obtain a very good mixture. In addition, the bath could be analysed and brought to correct composition before tapping.

Silicon Content Qualified

Mr. Sanders congratulated Mr. Goodwin on making good malleable out of his mixture; good malleable, whether blackheart or whiteheart, was very dependable. Mr. Davies qualified his 1 per cent. silicon for castings of $\frac{1}{8}$ in. section. Frankly it seemed very thin, and such thin sections had fortunately never been his (the speaker's) experience. In the thinnest class of work, such as conduit fittings, 0.8 per cent. silicon was specified, and for pipe fittings a little lower. Many castings were sold at so much for each and the foundry was anxious to cut down the section thickness, so that the result was a compromise between making good castings and not giving away too much weight. The quotation from Dr. Hatfield's experiments was very interesting; when it was studied it was realised that it was practically modern whiteheart practice.

Regarding the statement about 48 hrs. at the annealing temperature, the author writes:—

> "The practice I use, and have used for the past 15 years, is to light the furnace on, say, Thursday night at 5 p.m. The furnace, 3 tons capacity, is well up to heat by 5 p.m. on Friday; firing is continued on Saturday and until 5 p.m. on Sunday, making 48 hours' firing time at heat. At about 8 p.m. on Sunday the front of the furnace is pulled down and the furnace is unpacked on Monday. I have only five annealing furnaces, and get five ovens per week from them. The furnaces are not mechanically charged; all packing and unpacking is done inside the furnace. Most of the castings are of light section, but the thicker sections are placed on the fire side of the furnace, where the temperature is greatest. A strong mixture of ore, 1 to 3 is used for thick sections. The mixture is a hematite steel mix with analysis as follows:—Silicon, 0.5; sulphur, 0.14; manganese, 0.30; and total carbon, 3.0 per cent."

MR. J. ROXBURGH said, although the Paper was intended as a survey, he would suggest that, being so general in character somewhat detracted from its value, as it was only by the study of the details of the production of a great variety of malleable castings that the inherent difficulties and problems were revealed.

Characteristics of Malleable Casting

Fundamentally, malleable iron had a higher casting temperature, a higher initial freezing point, a shorter freezing range and higher solid contraction than cast iron. The two phenomena, which exerted the greatest influence, therefore, were liquid shrinkage and solid contraction, although the running properties of malleable iron presented difficulties,

Whiteheart Malleable Castings

too. The running and feeding of malleable castings, as well as the precautions to be taken to avoid trouble due to solid contraction, were considerations even more vital than with grey-iron castings.

In view of this, initially, the design of malleable castings was most important, and he felt that, in the main, judging from the foundry aspect, greater consideration should be, and was, given to this question with malleable castings than was the case with grey-iron castings, and, quite frequently, the manufacturer, before commencing production, was obliged to ask the customer for some alteration to design to ensure soundness in a particular casting or to facilitate production. These suggested alterations almost invariably were approved, and by such co-operation mutual benefit was derived.

The behaviour of the casting, after pouring, in changing from the liquid to the solid state, was most important, and it was the aim of the manufacturer to endeavour to control or direct such solidification, so that appropriate measures might be adopted to guarantee a sound casting. The disposition of the runners and feeders were therefore determined with this object in view, and where thick and thin sections occurred in a casting, the difficulties of feeding were increased, particularly if the thick sections of the casting, due to the method of moulding adopted, were so placed in the mould as to render them difficult of access. There were several types of feeders in general use, such as top feeders, side feeders, joint feeders, running feeders and off-feeders.

Mr. Roxburgh then emphasised that the ratio of feeder and sprue to the weight of casting was important, particularly so in wartime, and had found by experience that the investigation of this question had well repaid him.

Defects and Mould Material

Regarding defects, which occurred in malleable castings, there were those which were common to any casting, but in addition there were others which were peculiar to them, to some of which the author had made reference. He mentioned that cracking was liable to occur with certain castings, but omitted to refer to "hot tears," "pulls," warping and distortion. Special precautions had to be taken to endeavour to avoid much trouble, and the use of "ties," brackets, lightening out of cores, etc., was resorted to.

Another question, which was important, was the material which constituted the mould. Malleable castings were usually made in green-sand moulds, but variations in results could be obtained by the use of natural moulding sand as compared with synthetic sand, the latter usually having less moisture content, and higher bonding strength and permeability. Again, the use of denseners in moulds should be avoided where possible, but they were quite frequently employed to ensure soundness. A combination of feeder and densener could be very effective, particularly from the point of view of reducing the amount of feeding metal required and ensuring that the casting was white and free from graphite as cast. The cleanliness of running of any casting was important, but with malleable iron, strainer bushes and "grids" should invariably be used to prevent slag or sand entering the mould.

Mr. Roxburgh said they were all indebted to Mr. Sanders for having presented the author's Paper and for dealing with the discussion.

MR. SANDERS, in reply, said that unfortunately there was little detail in the Paper regarding the gating and feeding of malleable castings. He did not know Mr. Davies' foundry but he imagined it was very different from the one where Mr. Roxburgh was engaged, which manufactured the most comprehensive range of castings in the country, from the lightest to the largest and most complicated. Malleable castings ranged from ironmongery fittings to heavy engineering castings, and obviously the former did not present many problems to the foundry manager. His chief problem was to make them cheaply and quickly.

Control of Solidification

He agreed that malleable iron had a high liquid shrinkage and high solid contraction which made the founding a much more difficult problem than with grey-iron castings. The only way to tackle these problems, especially if the order was for a large number of castings, was first to study the drawing and see if any useful modification of design could be made. Secondly, various methods of moulding, gating and feeding should be tried off a loose pattern and when these points are finalised the plates with runners and feeders can be adjusted and put into production. A study of directional solidification would indicate where the feeders were to be placed. The top feeder was very useful but one had to be very careful to avoid sinking around the feeder, caused by the weight of feeder forcing the supporting sand into the casting. The side feeder on the joint was generally superior, particularly in production moulding.

He asked what Mr. Roxburgh meant by the

Whiteheart Malleable Castings

off-feeder? The value of a chill under a section of the casting which was also fed was emphasised, one advantage was that less feeder was necessary and another was that it removed the danger of primary graphite. Mr. Davies gave some ideas about normalising to prevent cracking brought about by casting stresses in the mould. Whiteheart castings were much more liable to cracking than blackheart and with the thin plate type of casting the only way was to muffle the casting as soon as possible after casting to take care of solid contraction stresses. Any cores must be capable of collapsing quickly under contraction.

Information on the effects of synthetic *versus* natural sand was invited. Another difference between malleable and grey iron was the difficulty of keeping out slag inclusions to which whiteheart malleable was very prone. Mr. Sanders relied almost exclusively upon the spinner ingate, if this was quickly filled with metal it was possible to keep the dirt out of the castings.

"Over-Chilling"

MR. J. BUTTERS said, under the heading "Moulding and Casting," the author advises the use of chills, and states in the same sentence that overchilling should be avoided. What is overchilling? In the Paper, under the heading "Malleablising Process," the author states: "Often with some manufacturers the annealing period is as much as 8 days, but the general practice to-day is to regulate the silicon and carbon so that a metal mixture is used which will anneal in as little as 48 hours." Would the properties of the castings be as good in each case? If this be so, then the country was losing a lot of time in the malleable business.

MR. SANDERS, in reply, said that by the term "over-chilling" it was assumed that Mr. Davies was referring to castings cast completely or nearly so in chills such as the test-bars completely chilled. When casting in chills, there were fundamentally different conditions from casting in sand; the conductivity of the chill was greater, permeability was zero and the resistance of the chill to solid contraction was infinitely greater. There was also the question of the temperature of the chill which had a great effect in controlling the speed of solidification, particularly of the skin of the casting with the secondary effect on escape of gases.

The time of annealing depended upon two factors, the composition of the metal and the section thickness. Probably in the case cited by Mr. Davies the composition had the greater effect because it ensured the precipitation of temper carbon in thick sections so that these annealed in as short a time as the thinner section. With true whiteheart annealing, *i.e.*, with removal of carbon by oxidation and no graphitisation, for a thick casting the annealing time could easily be 8 days. If the manganese was a little higher the annealing time could be reduced considerably and a very good quality of malleable thus made.

Chills and Feeders

MR. E. HOLLAND said the Paper states: "Where a casting is being chilled, it must be well fed." Yet he failed to agree with this statement, as if it were well fed, it did not need to be chilled; chills usually being placed where feeders were impossible or not advisable. There was also a statement that a moulder used his heel or a hammer to break off the runner to prevent cracking or pulling. On a round plate type of casting this could not make much difference as the runner mouth was the weakest point owing to it being the last to solidify. The solid contraction around the periphery would pull this joint apart even if the runner was broken off.

He understood Mr. Sanders in his reply to Mr. Peace to state that the annealing oven was opened three hours after firing had ceased. He did not understand how successfully annealed castings could be obtained with this practice, as the drop in temperature from 980 to 710 deg. C. in three hours would be far too swift.

MR. SANDERS, in reply, said a chill was frequently used under a feeder in malleable practice. A feeder might be used alone, but a chill alone would not serve the purpose. It was generally admitted that a chill did not cure unsoundness, it merely removed it to another place. If the casting could be chilled in one place and fed in another, this was recommended, as the freezing rate of the part away from the feeder was accelerated. An example was given of two bosses on a casting joined by a web. A feeder could be used on each boss or one boss chilled to reduce the cooling rate to that of the web when a feeder on the other boss would adequately feed the casting.

Cleaning before Annealing

The correct time to clean whiteheart castings was before annealing. If sand was left on, the annealing process was delayed and the burnt-on sand was much more difficult to remove. If a long thin casting was run with several ingates from a long spray as grey iron practice, the cast-

(*Continued on page* 103.)

American Metallurgical Scene—9

AMERICAN STEELFOUNDERS AND THE WAR

At the annual meeting of the Steel Founders' Society of America, in February, the record number of over 200 executives discussed various problems which the war has brought to the producers of steel castings. At one of the technical sessions E. C. Barringer, of the Institute of Scrap Iron and Steel, discussed "The Steel Foundry Scrap Problem," and indicated the difficulties which members of his organisation have encountered in endeavouring to supply a steady flow of scrap. He suggested that complete allocation of scrap would be the most satisfactory solution for all concerned, but pointed to the difficulties encountered in such an operation. A large amount of scrap is available in the United States, and he suggested that proper steps must be taken to get it to the foundries and steelworks.

E. R. Young, Climax Molybdenum Company, spoke on molybdenum in the defence programme, and indicated the amount of molybdenum available for war work, referring to the essential and optional uses of molybdenum in steel castings. He also gave specific instances where that alloy should not be used to obtain certain properties and indicated that every effort should be made not to employ alloys where their use cannot be justified metallurgically or practically.

The use of aluminium in steel castings was discussed by W. Bonsack, who pointed out that in many war operations where aluminium scrap is produced, this scrap is contaminated with steel to such an extent that the secondary products cannot be returned as raw products to the same war industries. Yet this type of material provides an excellent source for metallurgical aluminium.

In the final Paper, prepared by H. F. Taylor and E. A. Rominski, Naval Research Laboratories, Washington, on "Atmospheric pressure and the steel casting —a new technique in gating and risering," the authors discussed in detail the blind risering method, and showed what has been done in that direction.

"The Rôle of the Steel Foundry Industry in the War," was the subject of an address by S. W. Utley, Detroit Steel Casting Company, Detroit, who pointed out that during normal times the greatest job of the producers of steel castings is to convince the engineering world of the superiority of steel castings. In his opinion, more progress related to the technical developments of steel castings has been made during the past ten years than in any previous decade in the history of the industry. Although steel castings have been thoroughly dependable during all of these years, this progress has made them even more so to-day.

Mechanised warfare has succeeded in selling engineers the fact that steel castings are a superior product to meet war needs. Ordinarily, several years would have been required to accomplish the selling job that has resulted quickly from the tremendous demand for production of war machines. Mr. Utley suggested that the industry should not accept orders for steel castings where it is known that particular provisions of the specifications cannot be met in a technical and practical way. Effort should be made to have such specifications changed before the work is undertaken.

ALCOA DEVELOPMENTS

Aluminum Company of America in 1941 made a net income of $40,882,134 after depreciation and taxes, etc., equal after preference dividends, to $22.90 a share. This compares with adjusted net income of $46,522,470 or $26.73 a common share in 1940. The war requires that the United States produce annually almost seven times as much aluminium as it produced in 1939 [about 163,500 net tons]. Toward that end Alcoa, in a little over a year, has more than doubled the production rate which required 50 years for it to attain. Facilities for fabricating most forms of the metal have already been doubled, and facilities for certain forms have been increased to more than six times what they were when the war started. At the beginning of 1939 Alcoa had 138,500 tons of aluminium on hand, or more than it had sold in the entire previous year. By the end of 1940 this stock had been reduced to 77,000 tons, but despite the heavy 1941 demand the inventory was increased substantially by the end of the year. The company is hopeful that new uses for aluminium and expansion of the old applications plus the present lowered selling prices will make it possible for the nation to consume the production of the greatly increased capacity after the war. Production of new aluminium increased 46 per cent. and net deliveries were 22.8 per cent. higher than in 1940.

AMERICAN BAUXITE IN 1941

The Bureau of Mines announces that United States 1941 production of bauxite at approximately 899,500 long tons, exceeded the previous peak of the World War year of 1918 by 50 per cent. and surpassed the 1940 output by 105 per cent. Of the 1941 production Arkansas contributed 92 per cent. and Alabama, Georgia, and Virginia the remaining 8 per cent. According to the Department of Commerce, bauxite imports during the first nine months of 1941 were nearly 750,000 tons or 75 per cent. above the corresponding 1940 period. Of the 1941 imports, Surinam furnished 85 per cent., British Guiana 10 per cent., and the Netherlands Indies 5 per cent. Imports from Surinam and British Guiana totalled 637,579 and 75,603 tons, respectively, advances of 52 per cent. and 731 per cent. over those of the 1940 period. Of the bauxite exports during the first nine months of 1941, 86,557 tons were classified as bauxite and other aluminium ores, 11,448 tons as other bauxite concentrates, and 18 tons as alumina. As usual Canada probably was consigned all but a small quantity of these exports. Consumption in the United States last year was estimated at 1,700,000 tons compared with 1,072,000 tons in 1940.

MALLEABLE CASTINGS BY THE WHITEHEART PROCESS

(*Continued from page* 101.)

ing would cool first and contract, and would be in a stressed condition when later the runner spray cooled and contracted. It was better to knock off the runner before this could happen or, better still, to cast such a casting with two or more downgates, and to break off these to allow free contraction of the casting.

The cooling time from "cease fire" to opening of the wicket from 5 p.m. to 8 p.m. was surprisingly short. The oven was quite small, holding only 3 tons of castings, and would cool fairly rapidly, but not quickly enough for any ill effects on whiteheart castings in the cans.

Vote of Thanks

MR. R. H. BUCKLAND, in proposing a vote of thanks to the author and Mr. Sanders, said he had been particularly surprised at the very bold statements made by the author in the Paper. The author had said that it would not be correct to state that malleable castings were as good as or as dependable as the best steel forgings or castings. Actually a good malleable casting and a good steel casting were both dependable, but some steel castings were not reliable. He could not agree that chills were popular in malleable foundries, although they were apparently appreciated by Mr. Davies. However, he supported other speakers' views that chills could be used very profitably, especially in conjunction with feeders, where a considerable amount of feeding metal could be saved. After MR. POLLARD had seconded, the vote was accorded, and the meeting closed.

The Future of Vitreous Enamelling.—Progress of the vitreous enamelling industry will depend on widening its various fields of application, which can be done by finding and proving its utility for new purposes. Developments in recent years were discussed by J. E. Rosenberg at the annual conference of the American Ceramic Society, as well as the problems which the industry will face in a post-war period when new metals and alloys will compete for this market.

Flaking in Unalloyed Steels.—According to S. LIFSCHITZ, in "Stal," the principal macrodefect in a medium-hard, unalloyed steel is the formation of flakes. From a comparison of satisfactory melts and those in which flaking is very pronounced, the author recommends a clean hearth, the use of no corroded or wet scrap, hot melts, strong boiling, good slag formation with freshly-burnt lime, careful deoxidation, correct pouring temperature, and slow cooling of the ingots in the steelworks, and suitable heating of the ingots and slow cooling of semis in the rolling mill.

UNLICENSED ACQUISITION OF STEEL SCRAP

Recently Booth Bros. (Dial Foundry), Limited, were fined £20 and ordered to pay £10 10s. costs at a West Midland police court, for the unlicensed acquisition of steel scrap. It was the first case of the kind before the court.

Mr. L. C. Thomas, for the Ministry of Supply, said that in March, 1941, the firm applied to the Iron and Steel Control for a licence to acquire 50 tons of mild-steel scrap shearings per month. The firm's application was granted for three months, but within that period they acquired more than 177 tons, or 57 tons in excess of the quantity for which a licence was given. The proper control and distribution of raw materials essential to the manufacture of munitions, or for other war purposes, depended, said Mr. Thomas, upon the strict observance of the regulations.

On behalf of the firm, a solicitor submitted that the offence was purely technical. The firm, he said, was engaged solely upon essential Government work, and in the period covered by the licence they were rushed with orders.

NEW PATENTS

The following list of Patent Specifications accepted has been taken from the "Official Journal (Patents)." Printed copies of the full Specifications are obtainable from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1s. *each.*

544,439 ALUMINUM COMPANY OF AMERICA. Heat-treatment of aluminium base alloys.

544,450 UDY, M. J. Methods of producing alloys containing iron and chromium.

544,461 BONNYBRIDGE SILICA & FIRECLAY COMPANY, LIMITED, and MCBRYDE, W. Chequer brickwork furnace regenerator structures.

544,476 AMERICAN ELECTRO METAL CORPORATION. Method of manufacturing alloys, in particular steel alloys, and apparatus to perform it.

544,553 UDY, M. J. Production of chromium-bearing alloys.

544,560 BRITISH NON-FERROUS METALS RESEARCH ASSOCIATION, BAKER, W. A., and CHILD, F. C. Preparation for casting of non-ferrous metals and alloys.

SCIENTIFIC INTERCHANGE WITH U.S.S.R

Letters addressed by individual British scientists to individual Soviet scientists, or communications from British scientific and technical societies to the corresponding Soviet organisations, can in future be forwarded to the U.S.S.R. through the special committee on Scientific and Technical Interchange with the Soviet Union, set up jointly by the Ministry of Information and the British Council. Communications can be addressed either to Sir John Russell, Ministry of Information, or Mr. J. G. Crowther, Science Officer, the British Council, 3, Hanover Street, London, W.1. Envelopes to be marked: "Scientific Interchange with U.S.S.R."

NEWS IN BRIEF

THE PRESIDENT OF THE BOARD OF TRADE has appointed a Central Committee of Export Groups.

MR. J. TANNER has been re-elected president of the Amalgamated Engineering Union for the next three years.

THE LONDON OFFICES of the Butterley Company, Limited (engineering section) are now at 2, Caxton Street, London, S.W.1.

ASSOCIATED BRITISH ENGINEERING, LIMITED, has given notice to redeem the 5 per cent. funding certificates on July 15 next.

THE WARRINGTON BOND IRON SYNDICATE, LIMITED, is being wound up voluntarily. Mr. W. R. Murray, 1, Dickinson Street West, Manchester, is the liquidator.

OFFICIAL FIGURES show that the cost-of-living index on April 1 was 99 per cent. above the level of July, 1914, as compared with 100 per cent. on February 28 and 55 per cent. at September 1, 1939. The rise of 44 points since September, 1939, is equivalent to about 28 per cent.

THE JANUARY-FEBRUARY issue of "Foundry Practice," the house organ of Foundry Services, Limited, of Birmingham, has articles dealing with gunmetal and manganese-bronze test-bars; pickling of non-ferrous castings; a note on the feeding of aluminium castings; mixtures for firebars; and casting brass strip ingots.

A FURTHER INCREASE in wages took place in March. Changes resulted in an aggregate increase estimated at nearly £90,000 in weekly full-time wages of about 460,000 workpeople, and in a decrease estimated at £8,600 for 150,000 workpeople. Of the latter, about 80,000 had received increases of the same amount in February.

THE TIME HAS COME when the responsibility for war production should be set squarely on the shoulders of industry, helped by enlightened and intelligent planning from above and not burdened by a system of precedent and regulation, said Mr. Henry Robb when he presided at the annual meeting of Leith Chamber of Commerce.

WHEN THE FUTURE of Scottish industry was discussed in the House of Commons last week, Mr. T. Johnston, Secretary of State for Scotland, spoke of the hopes Scotland had in the Advisory Council on Scottish industry he had set up. He said that the industrial aftermath of the last war in Scotland, which had been due to Scotland's concentration on heavy industries for export, must not be repeated.

THE ESTABLISHMENT of a Council of Industry is recommended by the Association of British Chambers of Commerce in a report on post-war industrial reconstruction. The reports states that in any consideration of this far-reaching problem it is essential to formulate in the first place a short-term policy to be brought into operation immediately after the end of the war; at the same time, the Association welcomes the Atlantic Charter as providing a basis for a long-term economic policy.

PERSONAL

MR. A. G. LANG, of Siemens Bros. & Company, Limited, has joined the staff of Elliott Bros. (London), Limited, Century Works, Lewisham, S.E.13, as manager, measuring instrument sales.

DR. C. G. DARWIN, F.R.S., Director of the National Physical Laboratory, has been appointed Scientific Adviser to the Army Council. The Minister of Supply is appointing Dr. Darwin a member of the Scientific Advisory Council of the Ministry.

MR. C. H. KAIN, foundry manager of Lake & Elliot, Limited, of Braintree, has been elected a director of the company. Mr. Kain is a past branch-president of the Institute of British Foundrymen and the author of many valuable Papers on foundry subjects.

MR. WILLIAM HAMILTON, of General Refractories, Limited, and the Glenboig Union Fireclay Company, Limited, has been appointed liaison officer for Scotland for sands for foundries and steelworks. His address is 48, West Regent Street, Glasgow, C.2.

MR. R. A. MACGREGOR, who was formerly chief metallurgist with the Darlington Forge, Limited, Darlington, and who went to India some years ago, has agreed to continue his services as chief metallurgist to the Indian Government for another two years. Mr. MacGregor is Deputy Director-General in the Department of Supply.

OBITUARY

MR. GEORGE E. LINCK, who was well known in Glasgow as an agent for iron and steel, machinery and engineering firms, and who carried on business at 121, St. Vincent Street, Glasgow, died recently.

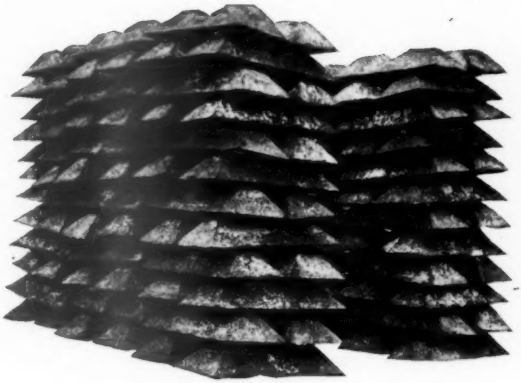
MR. WALTER ROBINSON, whose death has occurred at Rothbury, Northumberland, at the age of 87, was formerly well known in Tyneside shipping and shipbuilding circles. He was a member of the engineering firm of Edwards, Son & Robinson, of South Shields, which was eventually taken over by Smith's Dock Company, Limited.

MR. JOHN WILLIAM HARTLEY, chairman of Hartleys (Stoke-on-Trent), Limited, died recently at the age of 96. In 1870 he became chief locomotive draughtsman to the old North Staffordshire Railway at Stoke. Four years later he built the California Engineering Works at Stoke, starting this general engineering business with two partners. The firm continued for nearly twenty years, and during that time it made nearly all the bridges and railway chairs required for the North Staffordshire Railway. In 1895 he went to Stoke-on-Trent to become works manager for Kerr, Stuart & Company, and followed this with a period of business on his own account. When seventy-one years of age, in 1916, Mr. Hartley built a new engineering works at Etruria, and produced chairs for the North Staffordshire Railway. This business became Hartleys (Stoke-on-Trent), Limited.

AMERICAN OUTPUT of electric steel in 1921 was of the order of 500,000 net tons; in 1941 production attained the record figure of 2,920,000 tons.

STANTON

PIG IRONS *are* MACHINE CAST



The excellence of Stanton, Holwell and Rixons pig irons seemed to leave no room for improvement until Machine Casting came along. This method of manufacture eliminates sand, eliminates sows and produces a pig which is 100% iron and free from coarse graphite. It is clean working and economical of fuel in the cupola. Stanton Machine Cast Pigs have a shape which makes for easier handling and better stacking.

Specification

Weight	...	80—90 lbs.
Length	...	22 inches
Width	...	8¼ inches
Thickness (at notch 2 inches)	...	3¾ inches

New shape
Better stacking

The chemical analysis and well-known physical properties of each brand remain unaltered.

A modern Pig for modern needs

THE STANTON IRONWORKS COMPANY LIMITED, NEAR NOTTINGHAM

COMPANY NEWS

(Figures for previous year in brackets.)

Mason & Burns—Dividend of 20% (same).

Summerlee Iron—No dividend (1s. per share).

Kayser, Ellison—Interim dividend of 5% (same).

Alley & Maclellan—Final dividend of 7½%, making 15%.

John I. Thornycroft—Interim ordinary dividend of 5% (same).

Armstrong Stevens & Son—Ordinary dividend of 17½% (same).

Atlas Steel Foundry & Engineering—Interim dividend of 15% (same).

Herbert Morris—Interim dividend on the ordinary shares of 5%, free of tax (same).

Harrison (Birmingham)—Profit for 1941, £50,595 (£66,453); dividend of 20%, tax free (same).

Rio Tinto Company—Final dividend on the cumulative preference shares of 2½%, making 5% for 1941.

Babcock & Wilcox—Final dividend on the ordinary stock of 6%, plus a bonus of 1%, making 11% for 1941 (same).

Ransomes & Rapier—Net profit for 1941, after tax, £19,938 (£17,592); final dividend of 3%, making 5%, tax free (6%, tax free).

Kitchen & Wade—Final dividend of 5% for the year to March 31, 1941, making 30% (25% and bonus of 20%); also second interim of 12½% for 1942.

Smith & McLean—Profit for 1941, £49,669 (£54,327); to reserve, £10,000 (same); depreciation and obsolescence, £20,000 (same); ordinary dividend of 11% (same) and a bonus of 4% (same); forward, £63,786 (£62,242).

Victaulic—Profit for 1941, after depreciation, tax and E.P.T., £21,554 (£21,317); to special depreciation, £10,000; final dividend on preference and ordinary shares, 3%, less tax, with bonus of 7½%, free of tax, making 6%, less tax, with bonus of 15%, free of tax (same); forward, £10,530 (£10,226).

Ransomes, Sims & Jefferies—Net profit for 1941, after providing for E.P.T., income-tax, and A.R.P., £77,401 (£85,142); dividend on preference shares, £11,000; to reserve for post-war reconstruction and contingencies, £30,000; dividend on the ordinary stock of 7½% (same); forward, £54,624 (£55,723).

Robey & Company—Trading profit for 1941, £72,164 (£39,526); taxation and contingencies, £50,000 (£22,500); net profit, £13,024 (£6,810); available after interest, etc., on the income debenture stock, £19,344 (£15,711); dividend of 5% on the non-cumulative preference shares, £3,017; dividend of 5% (same) on the ordinary shares, £3,905; forward, £12,422 (£8,789).

William Asquith—Profit for year to August 14 last, after charging depreciation, £115,019 (£100,156); taxation, £104,000; dividend on the cumulative participating preference shares, £6,994; interest on the non-cumulative redeemable funding certificates, £1,058; dividend of 5% (same) on the ordinary shares, £2,040; forward, £30,206 (£29,279).

Colvilles—Profit for 1941, after providing for taxation and war damage insurance, £523,759 (£332,270); net dividends from subsidiary companies, £79,437 (£96,416); depreciation and obsolescence, £350,000 (same); dividend on the 5¼% cumulative preference stock, £57,062; interim dividend of 3% on the ordinary stock, £58,793; final dividend of 5%, making 8% (same), £97,989; forward, £157,710 (£119,858).

Stewarts and Lloyds—Consolidated profit for 1941, after providing for depreciation, war damage insurance premiums, E.P.T., N.D.C., and income-tax, £1,133,607 (£1,181,107); depreciation, £581,279 (£571,734); reserve against A.R.P. no longer required, £85,754; profits retained by subsidiaries for special appropriations, £213,931 (£239,151); net profit, £1,004,696 (£1,008,361); reserve for special depreciation, £100,000 (nil); contingencies, £250,000 (£350,000); dividends on preference shares, £119,215 (£123,431); dividend of 12½% (same) on the deferred stock, and at the appropriate rate on the liaison deferred shares, £525,295 (£534,050); forward, £192,875 (£182,689).

NEW COMPANIES

("Limited" is understood. Figures indicate capital. Names are of directors unless otherwise stated. Information compiled by Jordan & Sons, 116, Chancery Lane, London, W.C.2.)

Reddish Iron & Brass Foundry, 40, Brazennose Street, Manchester, 2—£1,500. T. Robertson and T. Robertson, jun.

Peter Kenton & Company—Engineers, ironfounders, etc. £3,000. A. Friedenberg, 607, Olive Court, Maida Vale, London, W.9.

E.P.C. Engineering Company, 823, Mansfield Road, Sherwood, Nottingham—£8,000. A. S. Caunt, T. R. Diggle and E. S. Bonser.

F. H. Burgess (Derby), Greenbridge Works, Stafford—Agricultural and general engineers, etc. £5,000. H. F. and W. D. Burgess.

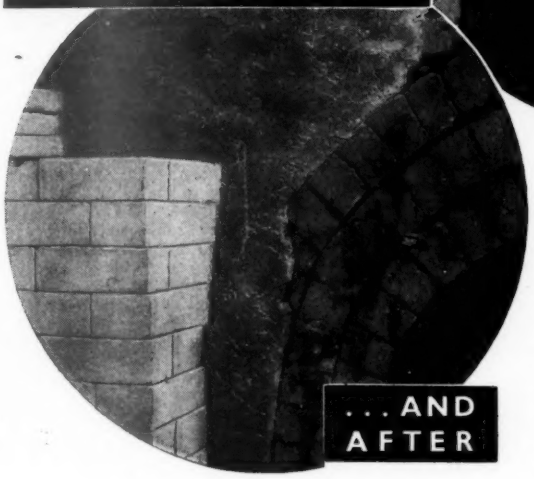
South Side Heat Treatment Company—Engineers, metal workers, etc. £500. I. Oscar, 9, Hampton Court, George Road, Edgbaston, Birmingham.

A. & S. Osmond, 254, Hotwell Road, Bristol, 8—To take over the business of the Osmond Engineering Company and to enter into a working agreement with Tubes & Fittings (Wholesale), Limited. £5,000. A. W. and S. H. Osmond.

CUTTING TOOLS CONTROL

The Control of Machine Tools (Cutting Tools) (No. 2) Order forbids the production of any cutting tool made from square or rectangular material if the cross-section, either way, exceeds ½ in., and if it is made in any other way than by welding or brazing the cutting portion of the tool, which may be of any high-speed steel, to the shank portion; this shank must be steel containing no tungsten, vanadium or cobalt. A second clause forbids the production of any cylindrical cutting tool that could be used with machine tools if in operation it is held by a shank of which the operative diameter exceeds ½ in. and if it is produced in any other way than as outlined above. Exceptions are where a licence is granted or a special or general direction is issued by the Ministry of Supply.

Patch WORN FURNACE BRICKWORK WITH Durax No. 1 PLASTIC FIREBRICK COMPOSITION



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Raw Material Markets

IRON AND STEEL

On the pig-iron side of the trade there is a very strong call for the better qualities, such as low- and medium-phosphorus iron and hematite, while quite substantial quantities of high-phosphorus pig are being absorbed, also. The latter is plentiful compared with other grades of iron, as it is produced from ores found in the United Kingdom, whereas other types are manufactured from imported ores, and cargoes of this nature have been materially reduced for some time past because of the lack of shipping space. Makers of light castings use high-phosphorus iron in normal times more than other consumers, but business in this trade is now at a low ebb, restrictions on home and export business having been imposed, so that demand for iron from these makers is considerably reduced. Recently, heavy engineers have come into the market for large supplies of high-phosphorus iron, which they have needed to eke out the reduced deliveries of other qualities. These concerns continue to share fully in war contracts and are committed far ahead. Hematite is particularly scarce, but the Control are despatching supplies where the use of this iron is really necessary for the carrying out of priority business, and there has been no hold-up in such instances.

Iron and steel scrap has been used more extensively by makers of heavy engineering castings since the industry had to seek an alternative to the better quality irons to which it had been accustomed, and the demand for scrap has assumed big proportions. Steel scrap is rather difficult to acquire, but the position in respect to cast-iron scrap has improved. On the whole, foundries have been able to return good outputs and their contribution to the national effort has been commendable. It is still hoped that the various Government departments will be able to make additional use of the resources of the light foundries, but so far there has been little indication that this will eventuate and prospects without Government assistance are poor.

Coke for foundry use is readily forthcoming o meet a brisk demand, and deliveries are arriving at their destinations promptly. Many of the larger consumers are under long-term contracts and these users can usually rely on having adequate reserve stocks on hand to tide them over any period when fresh supplies are held up; but there are buyers who rely solely on week-to-week deliveries, and it is these users who suffer when supplies are delayed. At present all consumers are getting excellent service from the coke ovens, and many buyers are now taking up extra tonnages for use later in the year.

Makers of special and alloy qualities of steel all over the country are receiving orders for still heavier tonnages; these grades are mostly required for munitions, aircraft and other urgent work, so that it is imperative that production be raised to the highest possible level. The scale of output is regularly being expanded, and developments in this section of the trade have been most gratifying in recent months.

NON-FERROUS METALS

The International Tin Committee has recommended the liquidation of the tin buffer pool, a measure which is hardly surprising in view of wartime conditions. The aim of the pool was to provide a buffer against violent fluctuations of price. At one period some 15,000 tons of metal was held, but that was soon moved into consumption at the outbreak of the war, the sum realised being rather less than £3,500,000. In 1940 a million sterling was distributed, and the remainder is now to be divided among the signatory countries in accordance with their contributions; the cash balance will be especially welcomed by the Malayan and Netherland East Indies companies. A short time ago these companies were liable for substantial E.P.T. payments in respect of current profits, so that any distribution from the buffer pool would have gone to the Treasury. Now that they are temporarily dispossessed of their properties, these companies have become entitled to E.P.T. refunds, and the return of the buffer pool balances will be a useful addition to liquid resources. About two-thirds of the present cash holding of the pool belongs to Malayan and N.E.I. companies. The work of the International Tin Committee is now in abeyance, but it is hoped to keep the Committee's machinery and statistical apparatus in being, in order to ensure continuity.

In reply to a question in the House of Commons by Wing-Commander Hulbert, Mr. Oliver Lyttelton, Minister of Production, said that during the past 12 months three small tin mines had been reopened in Cornwall, and the Non-Ferrous Mineral Development Control was investigating the more promising mines, dumps, and alluvial deposits. The closed mines were not equipped for immediate production, and efforts were being made to concentrate available skilled labour and material on the principal producing mines, to achieve the best possible production with the greatest economy of labour and time. It would thus seem that the Government is tackling the problems of the Cornish tin-mining industry, as foreshadowed, but it was never expected that production would be materially increased without considerable delay. South Crofty and Geevor are two of the principal producing mines; the East Pool & Agar Company announced last year that that mine was to close down, but, in the light of the changed conditions in the world tin situation, the Government has deemed it advisable to render aid to the company, and production is continuing. Steps to solve the labour problem have been taken, and exploratory work, including the resampling of old mining dumps, has been carried out.

With the demand for copper maintained at a high level it is gratifying to note that essential requirements are being met readily and in full. Supplies are by no means over-plentiful, however, and every effort is being made to encourage the use of secondary metal. The President of the American Metals Reserve Company has recently stated that copper productive capacity in the U.S.A. might increase by 200,000 tons a year when facilities at present under construction and planned were completed.

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